General Employee Radiological Training

Check Web Fileshare to make sure you have the most current version of RAD102
*(*https://wfsprod01.sandia.gov/groups/srn-uscitizens/documents/document/wfs284149.pdf*).*

Course Introduction

Sandia conducts a variety of work activities that involve the use of radiation and radioactive materials. Although the likelihood of exposure to radiation or contact with radioactive material is extremely low for the average person at Sandia National Laboratories (SNL), it is important that you be aware that radiological hazards exist in many locations, and know how to recognize them.

RAD102 retraining must be completed every 24 months. However, should there be a significant change to SNL radiation protection policies and procedures that affect Members of the Workforce, they will be notified and retraining will be required at that time.

Personnel who are current in Radiological Worker Training (i.e., RAD210, RAD230), Radiation-Generating Device Safety Training (RAD214), or Radiological Control Technician Training satisfy the requirements for RAD102.

Non-Radiological Workers who have completed RAD102 may be authorized to:

- operate "unattended" Radiation-Generation Devices (RGDs), as well as "Exempt Shielded" RGDs that are classified as either "inherently Safe" or "Certified Cabinet."
- operate/use equipment, etc, that contains inaccessible controlled radioactive material.
- use, or work with some conditionally controlled radioactive material (See RPPM Attachment 6-3 for specific restrictions an requirements).
- transport-non-exempt radioactive material in quantities less than, or equal to, RPPM Appendix E values.

Important:

Non-Radiological Workers, visitors, and tours, whether or not they have successfully completed RAD102, are NOT qualified or authorized to perform radiological work (such as:

- **operating an RGD that requires radiological training beyond RAD102;**
- **operating/using devices, equipment, etc., that contain accessible controlled radioactive material;**
- **working with controlled radioactive material;**
- **transporting non-exempt radioactive material in quantities greater than RPPM Appendix E values; or**
- **receiving more than 100 mrem in a year from occupational exposure)**

until they have successfully completed the appropriate level of Radiological Worker Training or RGD Safety Training.

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Course Goal & Objectives

Course Goal:

The primary goal of RAD102 is to provide you with the information you need to:

- recognize radiological hazards;
- become aware of the risks associated with exposure to ionizing radiation;
- become familiar with the terminology used in Radiation Protection; and
- keep the amount of radiation you are exposed to on the job As Low As Reasonably Achievable (ALARA).

Course Objectives:

When you have completed this training, you will be able to identify the following:

- Characteristics of ionizing radiation;
- Sources of natural background and man-made ionizing radiation and the average radiation dose that the general public receives from these sources;
- Methods used to monitor personnel exposures to radiation at SNL;
- The whole-body radiation dose limit for non-Radiological Workers;
- Risks associated with chronic exposure to ionizing radiation;
- The ALARA philosophy and basic practices;
- SNL's policy on the control of fetal exposure to ionizing radiation;
- Ways radiological hazards are posted and controlled;
- General employee, management, and Radiation Protection organization responsibilities for radiation safety at SNL; and
- Proper response to radiological emergencies.

Course Instructions

To receive credit for RAD102, you must:

- Review the information and answer the review questions in each module.
- Successfully complete (with a minimum score of 80%) the test at the end of the course. The test must be completed in one sitting. There is not a test-out option for RAD102.

Note:

Because this is a Service Center Course, there will be a charge per student.

Once you have completed the test and included your project/task number, send to Beth Watkins at MS-0653, or fax it to her at 505-844-2748, to receive course completion credit.

Who Must Comply

Members of the Workforce and DOE personnel who are non-Radiological Workers and require unescorted access to radiologically Controlled Areas must complete General Employee Radiological Training (RAD102), as a **minimum**, prior to occupational exposure to ionizing radiation.

RAD102 is also required for visitors who require unescorted access to Controlled Areas at SNL, and is recommended for visitors who will be escorted into Controlled Areas for periods exceeding 10 consecutive workdays. Visitor escorts must be current in RAD102, as a minimum.

Managers may authorize non-Radiological Workers who have completed RAD102, unescorted access to Radioactive Buffer Areas (RBAs), Radioactive Material Areas (RMAs), Fixed Contamination Areas, Soil Contamination Areas (SCAs), and Underground Radioactive Material Areas (URMAs) if **ALL** of the following conditions are met (as applicable):

- recent radiological surveys have demonstrated that contamination levels in the area are less than the limits specified in Attachment 6-1 of RPPM-06 (RMAs);
- no intrusive work will be performed; and
- RAD102-trained personnel requiring access to the area will not:
    - handle controlled radioactive material;
    - operate a radiation-generating device that requires a higher level of radiological training; or
    - receive more than 100 mrem in a year.

Module 1: Radiation Basics

After successful completion of this module, you will be able to identify the characteristics of ionizing radiation.

What is radiation?

Radiation is energy in the form of waves or particles. Radiation comes from sources such as radioactive material or from equipment such as x-ray machines or accelerators. Radiation can not be detected with any of the human senses, but it can be detected and measured very easily with various instruments. Radiation can be either **ionizing** or **non-ionizing**.

Ionizing radiation is radiation that has enough energy to cause ionization (the removal of electrons from the orbit of atoms). Examples of ionizing radiation include: **alpha radiation, beta radiation, gamma/x-ray radiation, and neutron radiation.**

When our bodies are exposed to ionizing radiation, the ionizing radiation deposits some (or all) of its energy to the affected cells/tissues in our bodies. The energy deposited is referred to as **radiation dose**. The radiation dose deposited in cells/tissues is then available to interact with (i.e., ionize) atoms, and produce harmful chemical changes and biological damage. Because of this, ionizing radiation should be treated with respect. Other terms commonly used in discussions about ionizing radiation include:

- **Radioactivity** – the process of radioactive (unstable) atoms trying to become stable by emitting, or giving off, excess energy (i.e., radiation).
- **Radiation** – the energy that is released from unstable atoms, and some devices, in the form of rays (or "photons") and/or particles.
- **Radioactive Material** – material that contains unstable atoms (i.e., radioactive atoms that emit radiation).
- **Contamination** – uncontained or uncontrolled radioactive material, usually in an unwanted location.

The other form of radiation is *non-ionizing* radiation.

Non-ionizing radiation is radiation that does **NOT** have enough energy to cause ionization. Examples of non-ionizing radiation include **microwave radiation, ultraviolet radiation, radar waves,** and **visible light**. These forms of radiation can still be harmful if proper care is not taken.

In this course, we are only concerned with ionizing radiation. All uses of the term "radiation" refer to ionizing radiation.

Module 1 Question:

1. **Two Examples of ionizing radiation are:**

    a) Microwave and gamma radiation.
    b) Alpha and ultraviolet radiation.
    c) Neutron and gamma radiation.
    d) Microwave and ultraviolet radiation.

Module 1 Answer Key:

1. c.

Module 2: Sources of Radiation

After successful completion of this module, you will be able to identify sources of natural background and man-made ionizing radiation and the average radiation dose that the general public receives from these sources.

Is ionizing radiation something new?

Absolutely not! Ionizing radiation has been a natural part of the Earth's environment since time began. We are constantly exposed to "background" radiation from the sun and stars above, materials in the earth beneath us, the very air we breathe and food we eat, and even our own bodies.

Since the late 1890's, man's activities and technological advances have contributed to this background radiation. These contributions include medical and dental sources (e.g., x-rays, radiation therapy), consumer products (older Coleman® lantern mantles, smoke detectors, radium dial watches, and older Fiesta Ware®), building materials, mining and milling (e.g., uranium, phosphate), nuclear power, and atmospheric testing of nuclear weapons.

The National Council on Radiation Protection and Measurements estimates that the average radiation dose received by members of the U.S. general population is approximately 624 mrem/person/year. This represents a significant increase from earlier estimates of 360 mrem/person/year, and is the result of the increasing exposures to radiation from medical applications (Ref. NCRP Report No.160, dated 03/03/09).

The average radiation dose (whole-body) received by a member of the U.S. general population is approximately **624 mrem per year**, from both **natural background** and **man-made sources of radiation**.

Comparison of Annual Radiation Doses from Selected Sources

Natural Background Sources of Radiation

Natural background radiation contributes about 311 mrem/year to the total average radiation dose received by members of the U.S. general population. The main sources of **natural background radiation** are:

- **Cosmic Radiation*** – radiation from the sun and outer space (~ 33 mrem/yr);

- **Terrestrial*** – radioactive materials in the Earth's crust (~ 21 mrem/yr);
- **Internal Emitters** – radioactive materials present in our bodies (e.g., Potassium-40, Carbon-14) (~ 29 mrem/yr); and
- **Radon** – radiation from the decay of naturally-occurring uranium in soil and building materials (~ 228 mrem/yr).

*The amount of natural background radiation received from cosmic and terrestrial sources varies across the continental U.S., with higher annual doses in the mountainous regions, and lower annual doses in the coastal regions.

Note: The unit of measure used for radiation dose, and the unit used to express the amount of biological damage caused by ionizing radiation, is the rem. Since, in most instances, radiation doses received are quite low, dose measurements are counted in thousandths of a rem, or millirem (mrem). [1 rem = 1000 mrem; 1 mrem = 1/1000 rem]

Man-Made Sources of Radiation

Man-made sources of radiation contribute the remainder of the average annual radiation dose received by members of the U.S. general population (approx. 313 mrem/person/year). **Man-made radiation** sources include the following:

- **Medical uses**** – x-rays and nuclear medicine procedures (~ 300 mrem/yr);
- **Consumer products**** – smoke detectors, self-illuminating exit signs, lantern mantels, thoriated welding rods, tobacco products (~ 13 mrem/yr);
- **Low-level emissions** – radioactive emissions from the nuclear power industry (< 1 mrem/yr); and
- **Occupational activities** – work on, with, or near radioactive materials and/or radiation-generating devices (< 1 mrem/yr).

**Radiation doses received from medical exposures and consumer products are probably the least recognized by the U.S. general population.

Typical Doses Received from Medical Uses and Consumer Products:

RADIATION SOURCE	TYPICAL DOSE
Cigarette Smoking (1.5 packs/day)	8,000 mrem/year (to bronchial epithelium)
Uranium-Glazed Dishes (e.g., Old Fiesta Ware®)	2,400 mrem/year (to whole-body)
Radium Dial Watch	6 mrem/year (to wrist)
Smoke Detector	1 mrem/year (to whole-body)
Medical Chest X-Ray	20 - 50 mrem mrem/shot (to chest)
Mammogram	400 mrem (to breast)

Low-Dose Mammogram (screen)	0.2 mrem (to breast)
CAT Scan	1,500 - 5,800 mrem
Fluoroscopic Procedure	5,000 mrem/min. (to skin)
Radiation Therapy	600,000 mrem (to tumor site)
Dental X-Ray	55-65 mrem/shot (to gums)

Important:

Regardless of the source(s) of radiation that we are exposed to, it is important to remember that although we may work with radioactive materials and/or radiation-generating devices, we ourselves do not become radioactive; nor do we get contaminated, unless loose radioactive contamination comes into contact with our skin or clothing.

Module 2 Questions:

1. **The general public receives an average radiation dose of approximately 624 mrem/year from what sources?**

   a) Man-made and non-ionizing radiation sources
   b) Natural and cosmic radiation sources
   c) Occupational and non-occupational radiation sources
   d) Natural background and man-made radiation sources

2. **Examples of sources of natural background radiation include:**

   a) Dental x-rays, fallout, consumer products, and radon.
   b) Cosmic and terrestrial sources, internal emitters, and radon.
   c) Radon, cosmic and medical sources, and consumer products.
   d) Smoke detectors, internal emitters, radon and cigarettes.

Module 2 Answer Key:

1. d.
2. b.

Module 3: Risks in Perspective

After successful completion of this module you will be able to identify the risks associated with chronic exposure to ionizing radiation.

The risks associated with occupational exposure to radiation (within DOE limits) are very small. They are considered acceptable when compared to the risks associated with other occupations (e.g., coal mining, farming, construction work) and other risks that we accept every day.

Contrary to what you see and hear in the media, exposure to radiation does **NOT** enable you to crawl up walls or buildings. Nor does it turn your skin green, give you super-human strength, make you glow in the dark, or cause you to grow 50 feet tall.

Biological Damage from Exposure to Radiation

The amount of biological damage caused by exposure to radiation depends upon:

- the type(s) of exposed organ(s) or tissue(s);
- the type(s) of radiation involved;
- the size of the radiation dose received; and
- how long the exposure lasted.

Potential Effects from Acute Exposure to Radiation

A radiation dose delivered in a short period of time, such as seconds to a few days, is considered an **acute dose**. Acute doses may be small, or they may be quite large. ***If*** doses are high enough, the exposed individual may experience hair loss and sickness (e.g., from radiation cancer treatment), or the individual may experience cataract formation, burns to the skin, organ dysfunction, or even death (e.g., during severe accident situations).

It is important to note, however, that these effects are rare and are not seen as a result of exposure to background radiation or from normal occupational exposure. At SNL, the chances of anyone receiving high-level acute doses are extremely remote.

Potential Effects from Chronic Exposure to Low-Level Radiation

A small dose of radiation received over a long period of time is considered a chronic dose. Such doses are received from natural background, routine medical and occupational radiation exposure at SNL, and ***may*** cause biological effects in the exposed individual.

One potential biological effect caused by chronic exposure to low-level radiation is an increased risk of developing cancer at some point in time. However, these risks are quite small when compared to the natural occurrence of cancer in the general population. Compared to other risks we accept everyday, occupational exposure to low-level radiation is extremely safe.

Prenatal Exposure

A developing embryo/fetus is especially sensitive to environmental factors, including radiation. Radiation dose to an embryo/fetus may increase the chances that the unborn child will develop conditions such as slower growth or mental development, or childhood cancer. These effects can also be caused by many other hazards in our environment (e.g., smoking or drinking during pregnancy).

The natural rate of birth defects in the U.S. is 11%. A dose of 25 rem (25,000 mrem) to the embryo/fetus may increase the chance of a birth defect from 11% to 11.1%.

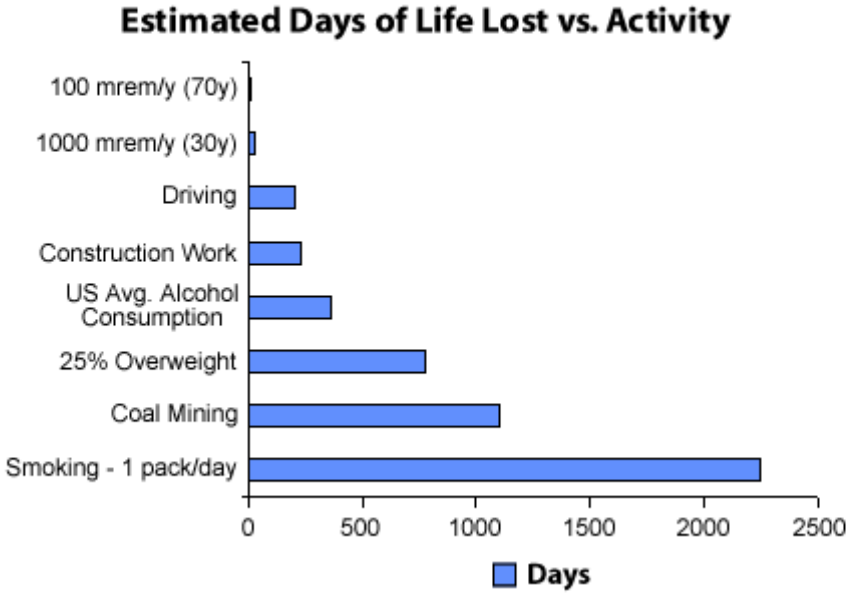
Hereditary Effects from Exposure to Radiation

A small possibility for hereditary effects in the future children of the exposed individual is assumed. However, to date, no hereditary effects have been observed in human populations that have been clearly linked to chronic exposure to low-level radiation.

Comparing Radiation Risks to other Health Risks

Compare the risk of working on, with, or near sources of radiation to the risks we accept as part of everyday life by using the charts as follows:

ONE IN A MILLION CHANCE OF DEATH
Smoking 1.4 cigarettes (lung cancer)
Spending 2 days in New York City (pollution)
Driving 40 miles in a car (accident)
Flying 2500 miles in a jet (accident)
Receiving 10 mrem of radiation (cancer)



Benefit vs. Risk

Accepting a risk is a personal matter, and each individual must weigh the benefit(s) against the potential risk(s). We know that there are many benefits from the uses of radiation. However, because it may harm us if we receive too much, we must learn to respect and work safely with and around radiation.

Module 3 Question:

1. **The risk of occupational exposure to radiation (within DOE limits) is considered:**

   a) Large.
   b) Medium.
   c) Small.
   d) Very small.

Module 3 Answer Key:

1. d.

Module 4: Radiation Dosimetry & Monitoring

After successful completion of this module, you will be able to identify methods used to monitor personnel exposures to radiation at SNL.

Since radiation can not be detected with any of the human senses, special detection and measurement devices must be used to determine how much radiation people have been exposed to.

Measuring Radiation Doses Received by Personnel

"Radiation Dosimetry" is the measurement of radiation dose. Personnel at SNL who work on, with, or near sources of radiation must be monitored regularly to determine how much radiation they have been exposed to on the job.

The device used at SNL to measure (indirectly) the **external radiation dose** received by personnel over a given period of time is the **ThermoLuminescent Dosimeter**, or **TLD**.

To work properly, TLDs must be worn on the front of the body, between the neck and the waist, with the round, mylar window facing outward. TLDs are not to be exposed to moisture or heat, opened, defaced, intentionally exposed, or otherwise tampered with.

If an assigned TLD is lost or becomes damaged, SNL's Radiation Protection organization should be notified immediately. A replacement TLD will then be issued for the remainder of the monitoring period.

Personnel who are issued SNL TLDs are asked to report any significant non-occupational radiation doses, including therapeutic radiation treatments and nuclear medicine procedures. SNL TLDs are not to be worn during such procedures.

Radiation dosimetry devices are required for use by:

- Personnel classified as Radiological Workers;
- Declared pregnant workers likely to receive doses to the embryo/fetus greater than 50 mrem during the gestation period (from external radiation sources); and
- Minors and members of the general public likely to receive greater than 50 mrem/year from Department of Energy (DOE)/SNL activities.

If personnel get radioactive material inside their bodies (e.g., via ingestion, inhalation, absorption, or injection) special monitoring may be needed to determine what kind of internal radiation dose they received. This special monitoring is called "Internal Dosimetry," and may include the collection and analysis of bodily specimens (e.g., urine, feces, blood, tissue), and/or the use of special radiation detectors placed close to the body.

The SNL Radiation Protection organization monitors dosimetry reports to help ensure that workers do not exceed their established dose limits. Personnel who are monitored for exposure to radiation and/or radioactive materials at SNL receive written reports on their measured radiation dose each year. Periodic reports are also distributed to SNL department managers. In accordance with 10 CFR 835, employees may access their individual dosimetry records at any time.

Module 4 Questions:

1. **The device that is used at SNL to measure the external radiation doses received by personnel is called the:**

   a) Thermoluminescent dosimeter (TLD).
   b) Thermoelectric monitoring device (TMD).
   c) Thermogenic radiation monitor (TRM).
   d) Total radiation monitor.

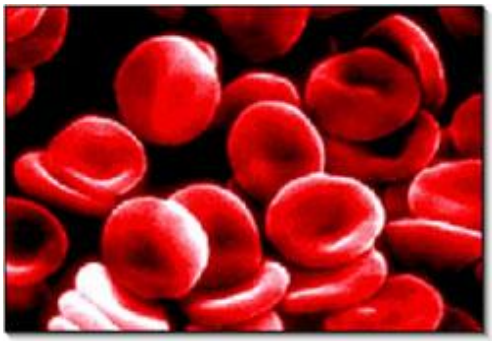
Module 4 Answer Key:

1. a.

Module 5: Radiation Dose Limits

After successful completion of this module, you will be able to identify the whole-body radiation dose limit for non-Radiological Workers.

Although it takes a large, single radiation dose of approximately 10,000 to 25,000 mrem to cause detectable health effects in the human body (i.e., a slight, temporary decrease in blood cell count), it is assumed that any radiation dose, no matter how small, could be harmful. Because of this, the DOE has established a limit on the maximum radiation dose that individual Radiological Workers and non-Radiological Workers (e.g., Members of the Workforce, visitors) alike are allowed to receive as a result of occupational exposure at DOE facilities.



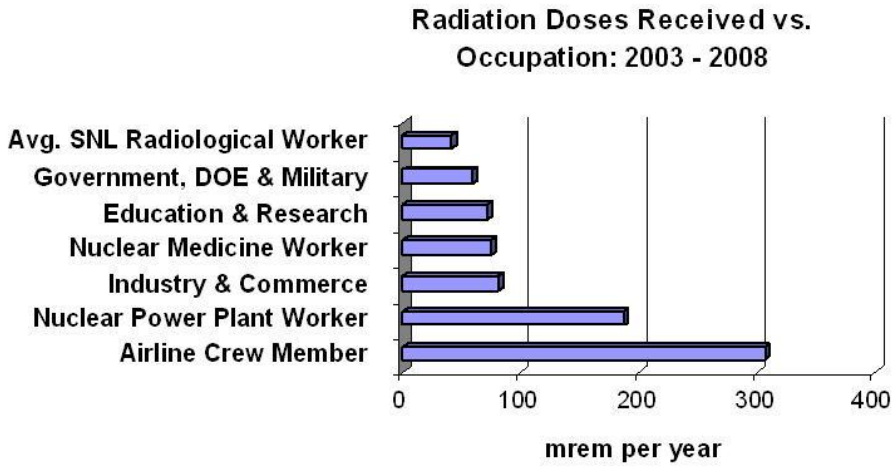
The DOE and SNL **whole-body occupational radiation dose limit** for all **non-Radiological Workers is 100 mrem/person/year**, which is less than one-third of that received from background sources of radiation each year.

Personnel involved in actual radiological work activities at SNL (i.e., "Radiological Workers") are allowed to receive higher dose, based upon the needs of their jobs. The **DOE whole-body occupational radiation dose limit** for **Radiological Workers** is **5,000 mrem/person/year**. The SNL level for Radiological Workers is well below this limit.

Although both of these dose limits are considered safe by radiation protection experts around the world, every effort is made to maintain doses as far below the limits as is reasonably achievable.

Occupational Exposure to Radiation

The average radiation dose actually received by SNL employees and contractors is 41 mrem/year. Let's compare this amount to the average occupational radiation doses received in other occupations:



Module 5 Question:

1. **The DOE yearly whole-body radiation dose limit for general employees is:**

   a) 10 mrem.
   b) 100 mrem.
   c) 2,000 mrem.
   d) 5,000 mrem.

Module 5 Answer Key:

1. b.

Module 6: ALARA

After successful completion of this module, you will be able to identify the ALARA philosophy and basic practices.

The **A**s **L**ow **A**s **R**easonably **A**chievable (ALARA) philosophy is the cornerstone of occupational radiation protection. It is based upon the assumption that any exposure to radiation, no matter how small, carries with it an increased level of risk for the worker. As a result, personnel are advised to maintain their radiation doses ALARA at all times, and to ensure that all radiation doses received are absolutely necessary for getting the job done. Personnel can use several simple practices to keep their exposure to radiation ALARA.

Maintaining occupational exposure to radiation **A**s **L**ow **A**s **R**easonably **A**chievable is an integral part of all SNL activities.

Reducing External Exposure to Radiation

The basic practices used to implement ALARA are:

- **minimizing your time** of exposure to radiation and radioactive materials;
- **maximizing distances** between yourself and radiation hazards; and
- **using appropriate shielding** materials between you and any radiation hazards.

In addition to these methods, the SNL Radiation Protection (NM) and Health & Safety (CA) organizations routinely monitor radiation levels in the workplace to determine the potential for external exposure to radiation. The results of monitoring activities are posted to inform employees of the radiological hazards in specific areas, and to assist them in maintaining their radiation doses ALARA.

Preventing Internal Exposure to Radioactive Material

Internal exposure to radioactive material (e.g., tritium) can result from intakes (e.g., inhalation, ingestion, absorption, and/or injection) of radioactive materials.

When there is a potential for the intake of radioactive material by the worker, appropriate ALARA techniques include: containment of unsealed radioactive material, use of protective clothing and equipment (e.g., respiratory protection), routine monitoring for contamination in the workplace, and additional training on contamination control. In addition, eating, drinking, smoking, chewing consumable goods (e.g., gum, tobacco), as well as applying cosmetics, are prohibited in areas where airborne and/or surface contamination exists.

Module 6 Questions:

1. **The philosophy that deals with maintaining exposures to radiation and radioactive material as low as possible is:**

   a) DOE.
   b) SWIM.
   c) ALARA.
   d) TLD.

2. **The basic practice(s) used to reduce external radiation exposures include:**

   a) Minimizing time of exposure to radiation and radioactive materials.
   b) Maximizing distances between yourself and radiation hazards.
   c) Using appropriate shielding materials.
   d) All of the above.

Module 6 Answer Key:

1. c.
2. d.

Module 7: Control of Prenatal Exposure

After successful completion of this module, you will be able to identify SNL's policy on the control of fetal exposure to ionizing radiation.

Policy on Control of Prenatal Exposure to Ionizing Radiation

The developing embryo/fetus is especially sensitive to environmental factors, including radiation. Any exposure of an embryo/fetus to radiation may increase the chances that the unborn child will develop conditions such as low birth weight, small head size, mental retardation, or childhood cancer.

Personnel of child-bearing capacity should be aware of the hazards associated with exposure to radiation, and should take special precautions to keep their exposures ALARA.

Pregnant Radiological Workers are **strongly encouraged to inform the Radiation Protection (NM) or the Health & Safety (CA) organization, in writing, of their pregnancy and the estimated date of conception**. Upon notification, the worker's job assignment and work location will be evaluated for radiological hazards.

Worker Responsibilities

It is the sole responsibility of the worker to decide whether or not to formally declare pregnancy and become subject to the established controls and dose limits. The declaration is completely voluntary. The worker must also decide whether or not to accept the risk resulting from exposure to ionizing radiation, since the welfare of unborn children is the responsibility of the parents.

SNL Management Responsibilities

SNL Management will provide the declared pregnant worker the option of a mutually agreeable work assignment, without loss of pay or promotional opportunity, such that further occupational exposure to radiation will not result and the dose limits will not be exceeded. Upon withdrawal of a declaration of pregnancy, the worker will resume normal work activities, without any work restrictions. Pregnant workers are protected from discrimination by Title VII of the Civil Rights Act of 1964.

Availability of Counseling

Counseling on the risks associated with exposure to radiation is available to all personnel at SNL by contacting the Medical and Radiation Protection Program Departments (NM), or the Health & Safety Department (CA).

Dosimetry for Declared Pregnant Workers

When a declaration of pregnancy is submitted, an estimation of the radiation dose received by the embryo/fetus prior to the declaration will be performed. If the declared pregnant worker is likely to receive a dose of 50 mrem, or greater, after the declaration, monitoring will be performed and supplemental dosimetry may be provided to the worker. If there is any potential for an intake of radioactive material, an internal dose evaluation may be conducted for the declared pregnant worker as well.

Dose Limits for the Embryo/Fetus

The DOE dose limit for the embryo/fetus for occupationally exposed Radiological Workers who have voluntarily declared their pregnancy is 500 mrem for the period from conception to birth. The DOE recommends that efforts be made to avoid exceeding 50 mrem per month.

Module 7 Question:

1. **A worker who is pregnant, and who is exposed to radiation on the job should:**
   a) Inform Radiation Protection (NM) or Health & Safety (CA), in writing of her pregnancy and the estimated date of conception.
   b) Inform the SNL Employee and Labor Relations Department, either by phone or memo, of pregnancy and due date.
   c) Contact the SNL Ombudsman, in writing, and advise him/her of the prognosis.
   d) Do nothing unless instructed to do so by Employee and Labor Relations.

Module 7 Answer Key:

1. a.

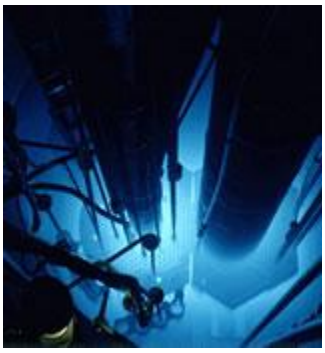
Module 8: Radiological Controls

After successful completion of this module, you will be able to identify ways that radiological hazards are posted and controlled.

Radiological surveys are performed to determine and document the conditions and hazards personnel are exposed to during radiological work activities. Such surveys are performed on the specific hazards themselves (e.g., radioactive material, radiation-generating devices), as well as the general areas where the hazards exist.

Survey results are used initially for hazard identification, and then for hazard mitigation and control. For example, radiological survey results are used to identify: posting/labeling requirements for areas and items; area entrance and work requirements (e.g., dosimetry, training, ALARA reviews, and personnel protective equipment); and the need for specific work controls.

In addition, to radiological surveys, engineered and administrative controls are used throughout SNL to help maintain personnel exposure to radiation and radioactive material at levels that are ALARA. The actual type(s) of control(s) used depend upon the facility, activity, and potential for mishaps.



Engineered controls include such things as:

- radiation shielding;
- containment;
- facility design; and
- safety interlocks.

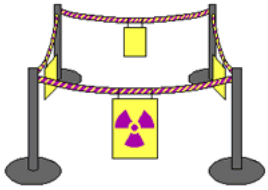
Administrative controls include such things as:

- radiation safety training;
- Technical Work Documents;
- Radiological Work Permits; and
- various radiological postings, labels, and tags.

Proper work planning also plays a key role in ensuring the safe conduct of radiological work activities at SNL and the safety of SNL personnel. This is effectively achieved through **detailed** pre-job planning, work procedures, radiological hazard identification and mitigation/control, monitoring of Radiological Workers for exposure to radiation and/or radioactive material, the use of personnel protective equipment, and personnel training. Proper work planning at SNL is rolled up in SNL's Integrated Safety Management System (ISMS).

All areas, materials, and devices at SNL that are controlled for radiation protection purposes are identified by posted signs, tags, or labels bearing appropriate warnings and the standard radiation caution symbol.

In addition, the color combination of **magenta** (or **black**) on a yellow background helps to make radiological hazards easy to recognize.



Radiological Postings and Labels

Radiological postings and labels help to alert personnel to the presence of radiological hazards. They also assist in minimizing personnel radiation exposures and preventing the spread of radioactive contamination.

Yellow and magenta rope, tape, chains, and other barriers are also used to define the boundaries of posted areas. In addition, yellow plastic wrapping bearing the magenta radiation symbol, or labeled containers, are used to package radioactive material.

CAUTION:

Never place an item with a radiological label in the trash or in a pile of things to be sent to Property Reapplication. Consult Radiation Protection (or Health & Safety) personnel for guidance in disposing of labeled items.

Radiological Postings

Postings (e.g., signs) inform workers of radiological conditions within a designated area, and usually prescribe area entry requirements.

A **Controlled Area** is any area to which access is managed in order to protect individuals from exposure to radiation and/or radioactive material.

A **Radioactive Material** Area is an area within a Controlled Area, designated for using, handling, or storing radioactive material.

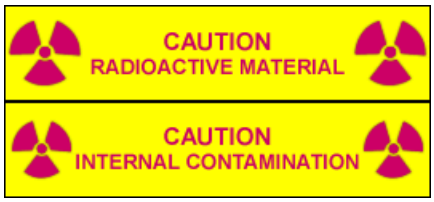
A **Soil Contamination Area** is an area containing radioactively contaminated soil. Additional wording, such as "SUBSURFACE CONTAMINATION EXISTS" and/or "CONTACT RADIATION PROTECTION PRIOR TO DIGGING," may also be used.

An **Underground Radioactive Material Area** is an area containing buried radioactive material. Examples include inactive radioactive waste burial grounds, radiological piping, covered ponds, or covered ditches.

A **Radiological Buffer Area** is an intermediate area established within a Controlled Area to prevent the spread of radioactive contamination, and to protect personnel from exposure to radiation.

A **Radiation Area** is an area within a Controlled Area where radiation dose rates greater than 5 mrem per hour, but less than or equal to 100 mrem per hour, exist.

Labels are used to identify specific radiological hazards, such as radiation-generating devices and radioactive material.



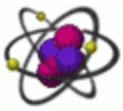
Technical Work Documents

Technical Work Documents (TWDs) are formally approved documents developed as part of implementation of the Integrated Safety Management System (ISMS). TWDs provide an administrative control to communicate activity-level work hazards and associated work controls during normal activities or foreseeable emergencies. The following are examples of TWDs used at SNL to control hazardous work:

- ES&H Standard Operating Procedures;
- Health and Safety Plans;
- Operating Procedures; and
- Permits, such as Confined Space Entry Permits and Safe Work Permits.

Radiation Safety Training

Radiation safety training provides personnel with the knowledge and skills needed for working safely with, or around, radiological hazards at SNL. This includes knowledge necessary for making informed decisions that affect personnel safety and health and impact the environment. It also includes skills necessary for safe entry into, work within, and exit from hazardous areas, as well as the use of instruments and equipment necessary for personnel safety.



Successful completion of RAD102 will qualify personnel (including visitors) to enter Controlled Areas at SNL without an escort, provided there is a need to have access to these areas.

(Note:** Some sites may require additional site-specific training for access.**)

Personnel who have not successfully completed RAD102 are *NOT* to be permitted unescorted access to Controlled Areas.

General Employee Radiological Training (RAD102) is acceptable for unescorted access to Radiological Buffer Areas, Radioactive Material Areas, Soil Contamination Areas, and Underground Radioactive Material Areas under very strict conditions and restrictions. See the end of the RAD102 Introduction for these conditions and restrictions.

Successful completion of RAD102 will NOT permit you to enter a Radiation Area unless you are continuously escorted by Radiological Worker trained personnel. Such escort does NOT authorize RAD102 trained personnel to perform radiological work!

Radiological Worker I Training (i.e., RAD210) is the minimum level of radiological training required to enter a Radiation Area without a trained escort, and/or to work with radioactive material, and/or to receive more than 100 mrem in a year from occupational radiation exposure.

Radiological Worker II Training (i.e., RAD230) is the minimum level of radiological training required for personnel requiring unescorted access* to one or more of the following:

- High Radiation Area
- Very High Radiation Area
- Contamination Area
- High Contamination Area
- Airborne Radioactivity Area

**Specific restrictions and requirements apply. Refer to RPPM-03, Radiological Training Program, Section 3.4.4 for details.*

Where can you find more information about radiation protection at SNL?

The SNL Radiological Protection Procedures Manual (RPPM) specifies the radiation protection standards and requirements that apply to all SNL and contractor facilities, locations, and activities involved in the use of radioactive materials and/or radiation-generating devices.

The RPPM communicates the requirements of 10 CFR 835, as well as the portions of the SNL Radiation Protection Program, that apply to all SNL employees, contractors, and visitors at SNL-controlled locations where ionizing radiation or radioactive material is present or used. In addition, guidance related to radiation protection in general, as well as implementing the requirements of the RPPM, is readily available from the Radiation Protection Program Dept. (at SNL/NM) and the Health & Safety Department (at SNL/CA).

Module 8 Questions:

1. **Areas controlled for radiological purposes are identified by:**

   a) Green flags or markers.
   b) Blue painted chains.
   c) Magenta (or black) and yellow signs.
   d) Orange and white signs.

2. **Successful completion of RAD102 will qualify personnel (including visitors) to do which of the following:**

   a) enter Radiation Areas without an escort, provided there is a need to have access to these areas.
   b) work with radioactive material, provided there is a need to perform such work.
   c) enter High Radiation Areas and Contamination Areas without an escort, provided there is a need to have access to these areas.
   d) enter Controlled Areas without an escort, provided there is a need to have access to these areas.

3. **The minimum level of radiological training required to enter a Radiation Area without a trained escort, and/or to work with radioactive material, and/or to receive more than 100 mrem in a year from occupational radiation exposure is:**

   a) ES&H Awareness Training (i.e., ESH100).
   b) Radiological Worker I Training (i.e., RAD210).
   c) Laboratory Standard Information and Training (i.e., LAB100).
   d) General Employee Radiological Training (i.e., RAD102).

Module 8 Answer Key:

1. c.
2. d.
3. b.

Module 9: Roles & Responsibilities

After successful completion of this module, you will be able to identify general employee, management and Radiation Protection organization responsibilities for radiation safety at SNL.

General Employee Responsibilities

You are responsible for:

- Observing and obeying all posted signs in Controlled Areas;
- Following all applicable ES&H standard operating procedures;
- Not entering Controlled Areas unless you are properly escorted or trained to be there (e.g., by completion of RAD102 training);
- Not entering Radiation Areas or performing radiological work without the necessary training or qualified escort;
- Doing what you are told when you are under escort;
- Completing appropriate training for your job assignment;
- Asking questions when in doubt;
- Telling your supervisor if you have any radiation safety concerns;
- Not removing materials or equipment from Radiological Buffer Areas without permission from Radiation Protection/Health & Safety personnel;
- Knowing how to contact the Radiation Protection personnel assigned to your Division ES&H Support Team;
- Complying with your area's emergency plan;
- Applying the ALARA philosophy at all times when visiting radiologically Controlled Areas; and
- Reporting unusual radiological situations.

Management Responsibilities

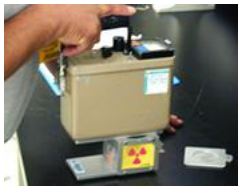
Managers are responsible for:

- Helping to ensure that radiation doses received by workers, visitors, and the general public are kept ALARA;
- Ensuring their workers have completed appropriate radiological training;
- Determining which workers require dosimetry;
- Identifying Radiological Workers; and
- Maintaining RAD102 completion/testing records for visitors.

Radiation Protection Organization Responsibilities

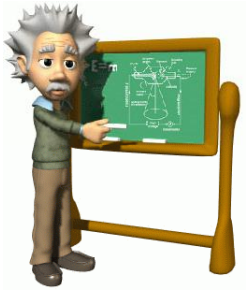
The SNL Radiation Protection organization consists of the Radiation Protection Department and the Health & Safety Department at SNL/California.

The Radiation Protection Department (4128) **owns the overall SNL Radiation Protection Program, and provides guidance/direction for the various entities and activities of the Radiation Protection Program**.



Radiation Protection Department personnel provide day-to-day radiation protection support for all radiological work activities throughout SNL/NM. Radiation Protection Department personnel perform radiation and contamination surveys, interpret radiation protection requirements (including 10 CFR 835), policies and procedures, and provide guidance for radiological work being planned or performed. The Radiation Protection Department is also responsible for the development and conduct of corporate radiation protection training (e.g., RAD102, RAD210, etc.), as well as the training and qualification of Radiological Control Technicians at SNL.

The Health & Safety Department (8517) provides radiation protection services and support for all radiological work activities at SNL/CA, as well as interpretation of RP policies and procedures.



Module 9 Question:

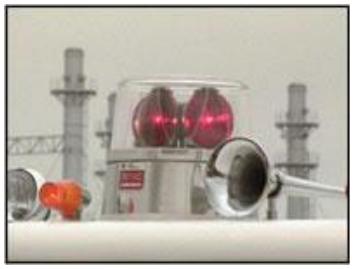
1. **General employee responsibilities for radiation safety at SNL include:**
   a) not entering Radiation Areas unless properly escorted or trained to be there.
   b) performing radiological work in radiological areas whenever possible.
   c) knowing how to prepare radiological work documents and perform radiation surveys.
   d) all of these.

Module 9 Answer Key:

1. a.

Module 10: Radiological Incidents

After successful completion of this module, you will be able to identify the proper response to radiological incidents.



Radiological incidents include such things as:

- a spill of radioactive material,
- radioactive material in an unauthorized location,
- a lost radioactive source,
- a fire in a radiological area,
- a motor vehicle accident involving a shipment of radioactive materials, etc.

In addition, radiological emergencies may involve radiological alarms that require immediate action.

Although radiological emergencies are highly unusual, if you suspect that one has occurred, you need to know:

- **Who to contact**
- **Where to go**
- **What immediate action to take**

1. **Who to Contact**

   Call 911 or the site emergency number from the nearest landline telephone.

   If you are using a cellular phone:

   - at SNL/NM, call (505) 844-0911, (505) 845-0911, or (505) 284-0911.
   - at SNL/CA, call (925) 294-2222.

2. **Where to Go**

   - Comply with the emergency plan for your building or site;
   - Go to the area where workers are supposed to gather to be accounted for in an emergency.

3. **What Immediate Action to Take**

   Comply with the emergency plan for your building or site:

   - If you see what you believe is radioactive material in an unauthorized location (for example, a radioactive source that has been discarded in a trash receptacle, or is found loose outside or in a building corridor):
     - Warn people in the vicinity;

- Assume ***temporary*** responsibility for the material and control access to the immediate area;
- Move to a safe distance - minimize your own exposure to the material; and
- Contact Radiation Protection (or Health & Safety) personnel.

- If you think you have become contaminated:
  - Stay put;
  - Stay calm;
  - Move and touch as little as possible; and
  - Request immediate help from Radiation Protection (or Health & Safety) personnel and the Medical Department.

- In addition:
  - Be alert to the warning sirens or alarms used at your work location; and
  - Provide the responding Incident Commander with as much information as you can regarding the incident.

Module 10 Question:

1. **In the event of a radiological incident, general employees need to know:**

   a) Where to find the fire extinguisher designated for flammable materials.
   b) Who to contact, where to go, and what immediate action to take.
   c) Where and how to shut off the air conditioning in their workplace.
   d) All of the above.

Module 10 Answer Key:

1. b.

Resources

Requirements

- RPPM Chapter 1 Radiological Work Planning and Controls
- RPPM Chapter 2 Posting and Labeling for Radiological Control
- RPPM Chapter 3 Radiological Training Program
- RPPM Chapter 4 Radiation Dosimetry
- RPPM Chapter 7 Radiological Design and Control and ALARA Application
- RPPM Chapter 11 Radiological Incidents
- RPPM Chapter 14 Declared Pregnant Workers

Additional Information

- **Radiation Protection Glossary**
- **Consumer Products Containing Radioactive Materials**
- **Cosmic Radiation**
- **Terrestrial Radiation**
- **Internal Emitters--Radioactive Materials in the Body**
- **Radon**
- **Medical Radiation**
- **Common Uses of Radioactive Material**
- **Food Irradiation**
- **Additional Information on Prenatal Risks from Exposure to Radiation**
- **What is a Dirty Bomb?**
- **What Does it Mean to be Contaminated?**

Final Test

Name _____ Org. _____ Date _____

Final Test Instructions

Required project/task number: _____/_____.

To receive course completion credit, send your completed test to Beth Watkins, MS 0653, or fax it to her at (505) 844-2748.

1. **Ionizing radiation is radiation that:**

   a) Is most often used for cooking frozen food.
   b) Has enough energy to remove electrons from atoms.
   c) Does not have enough energy to remove electrons from atoms.
   d) Is of no concern to most biological systems (e.g., humans).

2. **An example of ionizing radiation is:**

   a) Microwave radiation.
   b) Gamma radiation.
   c) Ultraviolet radiation.
   d) Infrared radiation.

3. **Non-ionizing radiation is radiation that:**

   a) Is most often used for cooking frozen food.
   b) Has enough energy to remove electrons from atoms.
   c) Does not have enough energy to remove electrons from atoms.
   d) Is of primary concern to most biological systems (e.g., humans).

4. **Examples of non-ionizing radiation include:**

   a) Gamma, neutron, alpha, and beta radiation.
   b) Nuclear, atomic, microwave, and ultraviolet radiation.
   c) Visible light and atomic radiation.
   d) Microwave and ultraviolet radiation, and visible light.

5. **The major sources of natural background radiation are:**

   a) Cosmic, medical, and the earth's crust.
   b) The earth's crust, radon, fission, and activated materials.
   c) The human body, the earth's crust, radon, and cosmic.
   d) Medical, the human body, and fission.

6. **The _____ is the device that is used to measure the external radiation doses received by personnel at SNL.**

   a) Thermogenic radiation device (TRD)
   b) Thermoelectric monitoring device (TMD)
   c) Thermoluminescent dosimeter (TLD)
   d) Total radiation monitor (TRM)

7. **What is the DOE whole-body radiation dose limit for general employees?**

   a) 100 mrem/year
   b) 500 mrem/year
   c) 2,000 mrem/year
   d) 5,000 mrem/year

8. **One of the possible biological effects associated with chronic exposure to low-level radiation is:**

   a) Immediate acute effects to the exposed individual.
   b) Temporary hair loss by the exposed individual.
   c) A 50% risk of fatality within 60 days.
   d) An increased chance of developing cancer.

9. **The risks associated with occupational exposure to radiation (within DOE limits) are _____. They are considered _____ when compared to risks that we accept every day.**

   a) large yet manageable; acceptable
   b) small; unacceptable
   c) very large; unthinkable
   d) very small; acceptable

10. **What ALARA practice is used to reduce a person's external radiation dose?**

    a) **Reduce** the **time** spent in a radiation area
    b) **Reduce** the **distance** from a source of radiation
    c) **Maximize** the **time** spent in a radiation area
    d) **Wear** radiation **dosimeters** as required

11. **A worker who is pregnant, and who is exposed to radiation on the job should:**

    a) Inform Radiation Protection (NM) or Health & Safety (CA), in writing, of her pregnancy and the estimated date of conception.
    b) Inform the SNL Employee and Labor Relations Department, either by phone or memo, of pregnancy and due date.
    c) Contact the SNL Ombudsman, in writing, and advise him/her of the prognosis.
    d) Do absolutely nothing unless instructed to do so by Employee and Labor Relations.

12. **Completing this course qualifies you to:**

    a) Refuse personal protective equipment.
    b) Participate in radiological work activities.
    c) Enter radiological areas ***without*** a qualified escort.
    d) None of the above.

13. **The minimum level of radiological training required for someone to enter a Radiation Area without a trained escort, and/or to work with radioactive material, and/or receive more than 100 mrem in a year from occupational radiation exposure is:**

    a) General Employee Radiological Training (i.e., RAD102).
    b) ES&H Awareness Training (i.e., ESH100).
    c) Radiological Worker Training (i.e., RAD210).
    d) Laboratory Standard Information and Training (i.e., LAB100).

14. **The minimum level of radiological training required for a visitor that requires unescorted entry into a Controlled Area is:**

    a) ES&H Awareness Training (i.e., ESH100).
    b) General Employee Radiological Training (i.e., RAD102).
    c) Radiological Worker I Training (i.e., RAD210).
    d) Laboratory Standard Information and Training (i.e., LAB100).

15. **Radioactive material can be easily identified by:**

    a) Postings.
    b) Symbols.
    c) Labels.
    d) All of the above.

16. **The primary radiation protection policy document that governs all radiological work at Sandia is the:**

    a) Radiographer's Safety Manual.
    b) Radiological Protection Procedures Manual.
    c) Radiological Control Manual.
    d) Radiological Work Permit.

17. **General employee responsibilities regarding the SNL Radiation Protection Program include:**

    a) Not entering Radiation Areas unless escorted or trained.
    b) Performing radiological work in radiological areas whenever possible.
    c) Knowing how to prepare radiological work documents and perform radiation surveys.
    d) All of the above.

18. **In the event of a radiological incident, general employees need to know:**

    a) How to clean up radioactive material spills while waiting for the fire brigade.
    b) Where to find the most recent copy of the MSDS for Tritium.
    c) Who to contact, where to go, and what immediate action to take.
    d) How to perform a Root Cause Analysis of the incident.

19. **If you see what you believe is radioactive material in an unauthorized location, you should:**

    a) Warn people in the vicinity.
    b) Assume temporary responsibility for the material and control access to the immediate area.
    c) Move to a safe distance and minimize your own exposure to the material.
    d) All of the above.

20. **If you ever suspect you have been contaminated (i.e., during a radiological incident), you should:**

    a) Return to your office as soon as possible and contact your supervisor.
    b) Finish your assigned work activity, then submit an occurrence report to the SNL Incident Commander.
    c) Stay put, stay calm, move/touch as little as possible, and request help from Radiation Protection (NM) or Health & Safety (CA).
    d) Immediately go home and shower with lukewarm water and mild soap.

RAD102 Feedback Form

Customer feedback is important to us. Please complete the evaluation form below and forward it to Beth Watkins, MS 0653, or fax it to her at (505) 844-2748.

Rate on a scale of 1- 5 (with 1= poor and 5 =excellent):

- The ease of using of this learning tool and/or test? 1 2 3 4 5
- The organization of information presented? 1 2 3 4 5
- The amount of information presented? 1 2 3 4 5
- The usefulness of the information presented? 1 2 3 4 5
- Your level of knowledge related to this topic BEFORE using this learning tool and/or test? 1 2 3 4 5
- Your level of knowledge related to this topic AFTER using this learning tool and/or test? 1 2 3 4 5
- The overall quality of this learning tool and/or test? 1 2 3 4 5

Fill in the blanks:

- What was most valuable about this learning tool or test?
  _____
  _____
  _____
  _____
- What information needs to be corrected, inserted, removed, or updated?
  _____
  _____
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  _____
- What could be done to improve or enhance this learning tool or test?
  _____
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